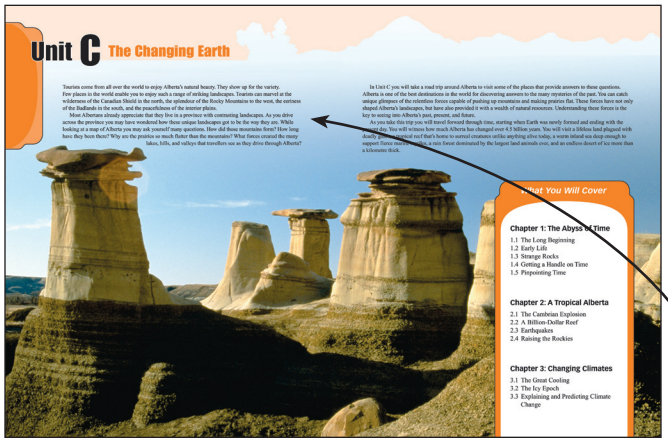
WELCOME TO Science 20

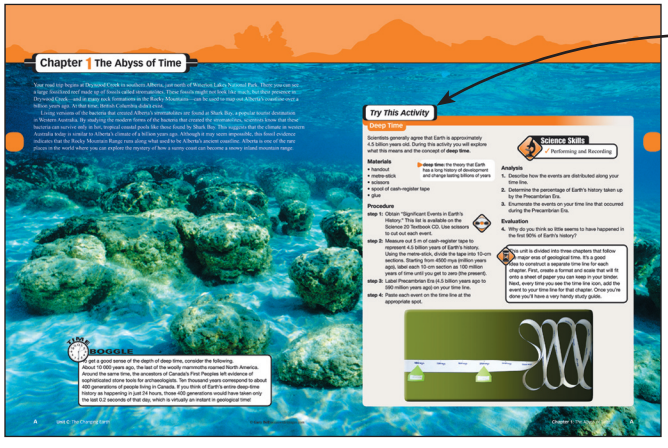
Units


Unit C The Changing Earth
What You Will Cover
Chapter 1: The Abyss of Time
1.1 The Long Beginning
1.2 Early Life
1.3 Strange Rocks
1.4 Getting a Handle on Time
1.5 Pinpointing Time
Chapter 2: A Tropical Alberta
2.1 The Cambrian Explosion
2.2 A Billion-Dollar Reef
2.3 Earthquakes
2.4 Raising the Rockies
Chapter 3: Changing Climates
3.1 The Great Cooling
3.2 The Icy Epoch
3.3 Explaining and Predicting Climate Change

Science 20 provides an opportunity for you to explore connections among societal issues, technologies, and science. Science 20 organizes these explorations into four units. They are Unit A: Chemical Change; Unit B: Changes in Motion; Unit C: The Changing Earth; and Unit D: Changes in Living Systems. Each unit opens with an introduction that establishes the theme. In the case of The Changing Earth, the theme is a geological tour through Alberta.

The introduction includes key questions that encourage you to begin to think about the main ideas to be explored in that unit.

Chapters

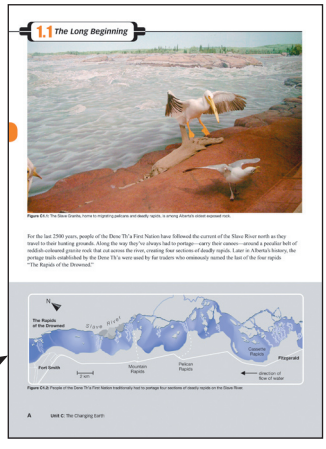


Each chapter begins with an activity. This is a hands-on learning activity that provides immediate contact with the science concepts developed in the chapter.

Each of the chapters within a unit focuses on one aspect of the theme for that unit. Chapter 1 of Unit C begins the story of the geological tour through Alberta with a description of the environment, the geology, and the major life forms that lived in Alberta billions of years ago.

Lessons

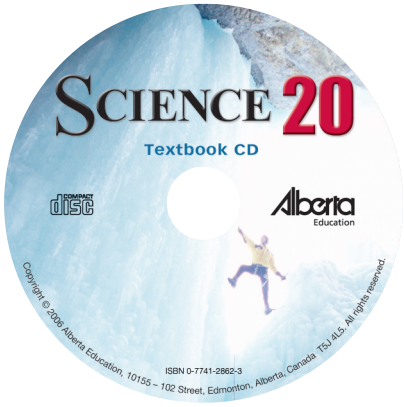
Among other topics, the first lesson of Unit C: Lesson 1, tells the story of the oldest exposed rock formation in Alberta. Connections are made to First Nations people, to the use of this area during the fur trade, and to Earth's internal structure.



Each lesson within a chapter focuses on a key science concept that links to the overall chapter's story line and the unit's theme. Throughout each lesson, a concept is presented in a story that weaves science knowledge and skills, societal issues, and technological applications.

Learning with Technology

Science 20 Textbook CD



Many activities require the use of a computer. In many cases, this means that you will have to access information on the Science 20 Textbook CD, which is attached to the back cover of the textbook. The information may be in the form of an applet, a computer simulation, a QuickTime video, a spreadsheet, or a handout needed to complete an activity.

LearnAlberta.ca

LearnAlberta.ca is a protected digital learning environment for Albertans. This Alberta Education portal, found at http://www.learnalberta.ca, is a place where you can support your learning by accessing resources for projects, homework, help, review, or study.

For example, LearnAlberta.ca contains a large Online Reference Centre that includes multimedia encyclopedias, journals, newspapers, transcripts, images, maps, and more. The National Geographic site contains many current video clips that have been indexed for Alberta Programs of Study. The content is organized by grade level, subject, and curriculum objective. Use the search engine to quickly find key concepts. Check this site often as new interactive multimedia segments are being added all the time.

If you find a password is required, contact your teacher or school to get one. No fee is required.

Alternative Learning Environments and Distance Learning

Although many students who enrol in Science 20 will be in a traditional classroom with a teacher, an increasing number of students will find themselves in alternative learning environments. The options include online/virtual schools, home education, outreach programs, and alternative programs.

Distance learning students can find customized resources on the Science 20 Textbook CD in the folder called Distance Learning Student Guide.

Visual Cues

Visual cues are provided throughout the textbook to help remind you about the special requirements of a particular learning activity.

Technology indicates that you will be using specialized computer software to complete the learning activity. The software could be designed for developing spreadsheets, multimedia presentations, or documents.

Internet Search is a cue reminding you that the activity requires you to complete a search to gather specific topic information. The activity will provide focusing questions that will help direct your searching.

Science 20 Textbook CD is a cue reminding you to access information on this CD. The information could be in the form of a computer applet, a data table, a spreadsheet, or some form of a handout.

Safety

Many learning activities in this course require you to be especially cautious because you will be dealing with potentially hazardous materials. The caution icon alerts you to the hazards and indicates helpful procedures and techniques.

Use gloves, safety glasses, and a lab apron for this activity.

Science Skills

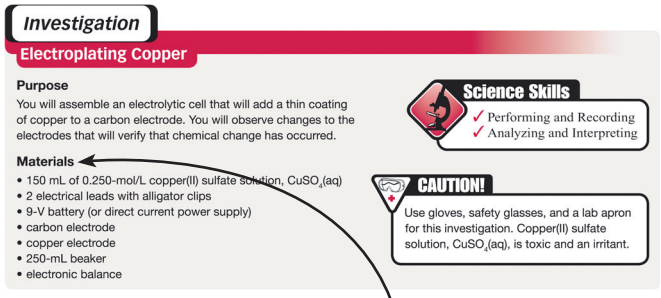
The specific skills that you will be practising in an investigation or in an activity are indicated by a visual cue. Some activities may require you to use only one skill, while others may require you to practise all of them.

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communication and Teamwork

Special Learning Activities

Investigations

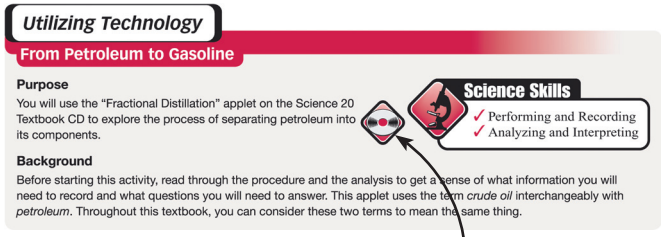
Investigations are opportunities to practise the inquiry skills of science.


Investigation
Electroplating Copper
Purpose
You will assemble an electrolytic cell that will add a thin coating of copper to a carbon electrode. You will observe changes to the electrodes that will verify that chemical change has occurred.
Science Skills
✓ Performing and Recording
✓ Analyzing and Interpreting
Materials
• 150 mL of 0.250-mol/L copper(II) sulfate solution, $CuSO_4(aq)$
• 2 electrical leads with alligator clips
• 9-V battery (or direct current power supply)
• carbon electrode
• copper electrode
• 250-mL beaker
• electronic balance
CAUTION!
Use gloves, safety glasses, and a lab apron for this investigation. Copper(II) sulfate solution, $CuSO_4(aq)$, is toxic and an irritant.

These experiments have been carefully designed so that you can use materials to learn skills and deepen your understanding of concepts.

Utilizing Technology

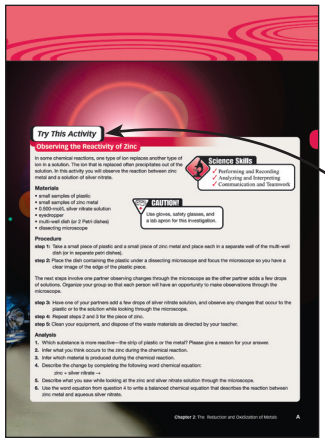
Utilizing Technology activities require the use of a computer.


Utilizing Technology
From Petroleum to Gasoline
Purpose
You will use the "Fractional Distillation" applet on the Science 20 Textbook CD to explore the process of separating petroleum into its components.
Science Skills
✓ Performing and Recording
✓ Analyzing and Interpreting
Background
Before starting this activity, read through the procedure and the analysis to get a sense of what information you will need to record and what questions you will need to answer. This applet uses the term *crude oil* interchangeably with *petroleum*. Throughout this textbook, you can consider these two terms to mean the same thing.

Many students find that an applet is a very effective way to learn about an abstract concept because the learning process is highly visual, and the pace of the activity is determined by the learner.

Try This Activity

A Try This Activity is a hands-on demonstration or exploration completed with simple equipment.



These activities are more concise than investigations.

Special Features

Did You Know?

The Did You Know? box identifies interesting information that relates to the concepts.

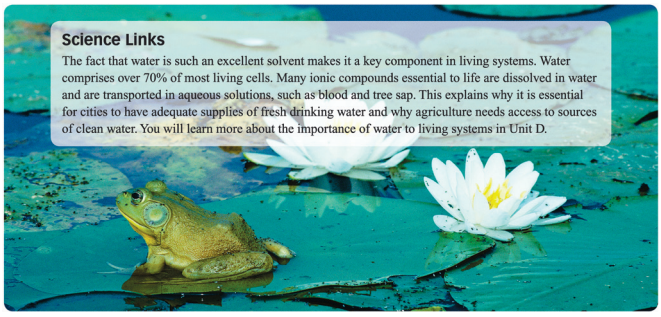
DID YOU KNOW?
Even though a forest fire can destroy lodgepole pine trees, only the heat from a wildfire can melt the resin that seals their pine cones shut. The parent trees may die, but within a few years the blackened landscape is dotted with lodgepole pine seedlings.

Time Line

This feature, found only in Unit C, identifies key events in geological time.

Science Links

This advanced organizer, found only in Unit A, identifies connections to related topics in the other units.


Science Links
The fact that water is such an excellent solvent makes it a key component in living systems. Water comprises over 70% of most living cells. Many ionic compounds essential to life are dissolved in water and are transported in aqueous solutions, such as blood and tree sap. This explains why it is essential for cities to have adequate supplies of fresh drinking water and why agriculture needs access to sources of clean water. You will learn more about the importance of water to living systems in Unit D.

Summarize Your Learning

At the end of each chapter you will have the opportunity to summarize the key ideas in a number of ways.

Summarize Your Learning

In this chapter you learned a number of new terms, concepts, equations, and techniques for problem solving. Now that you have come to the end of Chapter 2, this is an appropriate time to focus on the patterns within the things you have learned.

Since the pattern has to be in a form that is meaningful to you, there are some options as to how you can create this summary. Each of the following options is described on pages 552 and 553.

Option 1: Draw a concept map or a web diagram.	Option 2: Create a point-form summary.	Option 3: Write a story using key terms and concepts.	Option 4: Create a colourful poster.	Option 5: Build a model.	Option 6: Write a script for a skit (a mock news report).

Career Profile

Each unit ends with a career profile about how one individual established a science career.

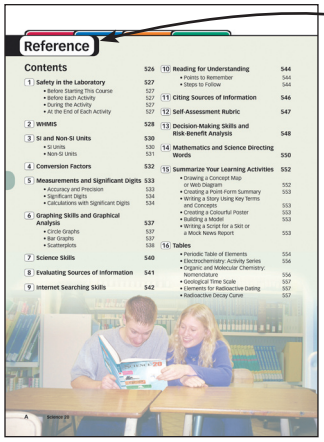
Career Profile

Metallurgical Engineer

Like lots of curious kids, Nalaine grew up asking a lot of questions. "When I was young, I found that I was always asking myself why," she recalls. As a kid, she was also fascinated by how stuff worked, "especially the industrial machinery at the sawmill where my dad worked." When Nalaine's dad had to go to work on a Sunday, she would tag along with him just to examine all the different machinery at the sawmill.

Nalaine always knew that when she left high school she'd be working towards a degree in engineering. "It just seemed like a normal path for me, and I wanted to be able to go back and work for my people." The difficult part was trying to figure out what field of engineering she should study. "I wanted to go into environmental engineering but found that [at the time] not many universities offered it."

Features at the Back of the Textbook


Reference
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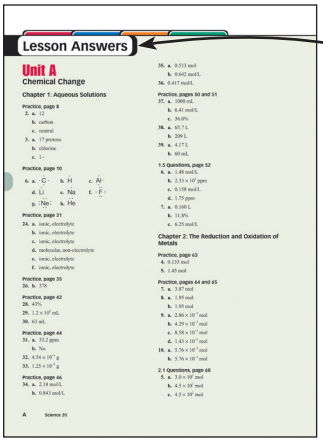
The Reference section at the back of this textbook contains helpful information that you will need to refer to throughout the course. In addition to tables and charts, you can find information related to safety and to a variety of learning strategies.

As you read the textbook, important terms are identified with a bold font. These terms are defined close to where they occur in the lesson, and they are also defined in the Glossary at the back of this textbook.



Short answers to questions asked within lessons can be found in the Lesson Answers section. This includes answers to practice questions and lesson review questions. Answers to investigations, chapter review questions, and unit review questions must be obtained from your teacher.

Assessment

Example Problems

When you first encounter a new type of problem that applies a concept to the unit's theme, an example problem will give you the essential coaching needed for success. When you reach the end of a chapter or a unit, use example problems as a tool for studying. If you cover up the solution and then re-attempt the problem, you can then compare your answer with the detailed solution.

Solutions to example problems include a list of data and any unit conversions.

Example Problem 1.16

A car travelling 90 km/h accelerates at 0.50 m/s^2 while passing another vehicle. If it takes 5.0 s to pass the vehicle, determine the distance travelled by the vehicle during this time.

Solution

Let the velocity, acceleration, and displacement vectors all point in the positive direction.

$$\vec{v}_i = +90\ \frac{\text{km}}{\text{h}} \times \frac{1000\ \text{m}}{1.0\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}} \qquad \vec{a} = +0.50\ \text{m/s}^2 \qquad \Delta\vec{d} = ?$$
$$= +25\ \text{m/s} \qquad \Delta t = 5.0\ \text{s}$$

$$\Delta\vec{d} = \left(\frac{\vec{v}_i + \vec{v}_f}{2}\right)\Delta t$$

Solving for $\Delta\vec{d}$ requires that you first find $\vec{v}_f$.

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$
$$\vec{v}_f = \vec{a}\Delta t + \vec{v}_i$$
$$= (+0.50\ \text{m/s}^2)(5.0\ \text{s}) + (+25\ \text{m/s})$$
$$= +27.5\ \text{m/s}$$

The car travels 1.3×10^2 m while passing.

Now, solve for $\Delta\vec{d}$.

$$\Delta\vec{d} = \left(\frac{\vec{v}_i + \vec{v}_f}{2}\right)\Delta t$$
$$= \frac{(+25\ \text{m/s}) + (+27.5\ \text{m/s})}{2}(5.0\ \text{s})$$
$$= +131\ \text{m}$$
$$= +1.3 \times 10^2\ \text{m}$$

Each step is clearly shown.

Helpful hints and reminders are included to keep the solution clear.

Practice Questions

Practice questions can be found throughout the lessons of each chapter. These questions are in the context of the lesson and are designed to check your understanding of the concepts.

Practice

6. David drives his quad 20.5 km into the back country to get to his favourite lake to fish for trout. If it takes 2.5 h to get to the lake, determine David's average speed in kilometres per hour and metres per second.
7. The sound waves from a thunderclap can travel 20.6 km in 1.0 min. Determine the speed of sound in metres per second.
8. During a track meet, Kelsey ran the 80-m hurdles event in 12.2 s. Determine Kelsey's average speed in metres per second and kilometres per hour.

Lesson Review Questions

Each lesson ends with review questions. These questions check your knowledge of important terms, your understanding of key concepts, and your ability to relate this learning to real-world applications.

1.9 Summary

The net force is the vector sum of all the forces acting on an object. For a vehicle moving on a road, the net force is the sum of the forces provided by the engine to move it forward and the resistive forces (such as rolling resistance and air resistance) that oppose the motion of the vehicle. Collectively, these resistive forces can be referred to as the force of friction. Applying Newton's second law in these circumstances often requires a calculation to determine the net force.

A special case occurs when the forces on an object are balanced and the net force is, therefore, zero. Newton's second law explains this circumstance by stating that since the net force is zero, the acceleration must also be zero. Another approach is to use Newton's first law, which states that when there is no net force, an object in motion will maintain its velocity and an object at rest will remain at rest. Newton's first law is also called the law of inertia because inertia is the property of an object to resist changes in its state of motion.

1.9 Questions

Knowledge

1. Draw two diagrams of a car on a highway. One diagram will illustrate the car travelling at a constant velocity. The other diagram will illustrate the car accelerating. Add labelled arrows to each of the diagrams to illustrate the relative size of each of the following vector quantities:
   - force of friction
   - applied force
   - net force
2. Which diagram in question 1 illustrates Newton's first law? Which illustrates Newton's second law? Explain.

Applying Concepts

3. A motorcycle and its driver have a combined mass of 224 kg. The engine generates an applied force of 1200 N, south, while the frictional forces exert 375 N, north. Let south be considered the positive direction for this question.
   a. Determine the acceleration of this motorcycle.
   b. Determine the time for this motorcycle to accelerate from rest to 65.0 km/h, south.
4. The following excerpt was taken from an operator's handbook for motorcycles, mopeds, and power bikes. These are some of the suggestions given to drivers of these vehicles when carrying a passenger:

When carrying a passenger, you should

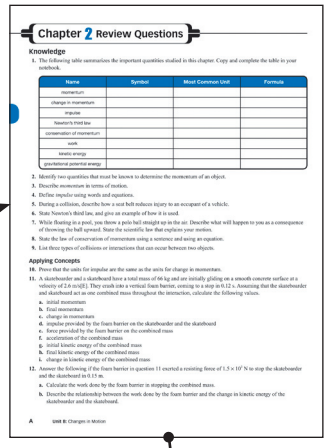
- operate at a lower speed, particularly on corners, curves, or bumps
- slow down earlier than usual when you approach a stop
- allow for a greater following distance

Use Newton's laws of motion to explain the rationale for each of these driving suggestions.

A Unit B: Changes in Motion

Chapter Review Questions

Chapter review questions provide an opportunity for you to apply knowledge, skills, and concepts from all lessons within a chapter. To answer one question, you will often be required to apply what you have learned in several lessons to a new situation.


Chapter 2 Review Questions

Knowledge

1. The following table summarizes the important quantities studied in this chapter. Copy and complete the table in your notebook.

Name	Symbol	Most Common Unit	Formula
momentum			
change in momentum			
impulse			
Newton's third law			
conservation of momentum			
work			
kinetic energy			
gravitational potential energy			

2. Identify two quantities that must be known to determine the momentum of an object.
3. Describe momentum in terms of motion.
4. Define impulse using words and equations.
5. During a collision, describe how a seat belt reduces injury to an occupant of a vehicle.
6. State Newton's third law, and give an example of how it is used.
7. While floating in a pool, you throw a polo ball straight up in the air. Describe what will happen to you as a consequence of throwing the ball upward. State the scientific law that explains your motion.
8. State the law of conservation of momentum using a sentence and using an equation.
9. List three types of collisions or interactions that can occur between two objects.

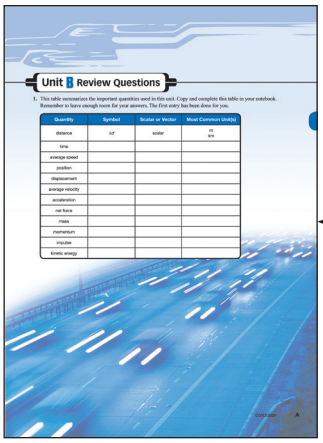
Applying Concepts

10. Prove that the units for impulse are the same as the units for change in momentum.
11. A skateboarder and a skateboard have a total mass of 66 kg and are initially gliding on a smooth concrete surface at a velocity of 2.6 m/s[E]. They crash into a vertical foam barrier, coming to a stop in 0.12 s. Assuming that the skateboarder and skateboard act as one combined mass throughout the interaction, calculate the following values.
    a. initial momentum
    b. final momentum
    c. change in momentum
    d. impulse provided by the foam barrier on the skateboarder and the skateboard
    e. force provided by the foam barrier on the combined mass
    f. acceleration of the combined mass
    g. initial kinetic energy of the combined mass
    h. final kinetic energy of the combined mass
    i. change in kinetic energy of the combined mass
12. Answer the following if the foam barrier in question 11 exerted a resisting force of 1.5×10^3 N to stop the skateboarder and the skateboard in 0.15 m.
    a. Calculate the work done by the foam barrier in stopping the combined mass.
    b. Describe the relationship between the work done by the foam barrier and the change in kinetic energy of the skateboarder and the skateboard.

A Unit B: Changes in Motion

Unit Review Questions

Unit review questions require you to apply what you have learned from all chapters within a unit. These questions focus less on specific details and more on connections between the key concepts, and on how these concepts relate to the unit theme.


Unit B Review Questions

1. This table summarizes the important quantities used in this unit. Copy and complete this table in your notebook. Remember to leave enough room for your answers. The first entry has been done for you.

Quantity	Symbol	Scalar or Vector	Most Common Unit(s)
distance	Δd	scalar	m, km
time			
average speed			
position			
displacement			
average velocity			
acceleration			
net force			
mass			
momentum			
impulse			
kinetic energy			